AMENDMENTS TO THE SPECIFICATION

Please replace the paragraph beginning on page 23, line 6 and ending on page 23, line 20 with the following:

It is a further aspect of the present invention that the personal communication system (PCS) infrastructures currently being developed by telecommunication providers offer an appropriate localized infrastructure base upon which to build various personal location systems (PLS) employing the present invention and/or utilizing the techniques disclosed herein. In particular, the present invention is especially suitable for the location of people and/or objects using code division multiple access (CDMA) wireless infrastructures, although other wireless infrastructures, such as, time division multiple access (TDMA) infrastructures and GSM are also contemplated. Note that CDMA personal communications systems are described in the Telephone Industries Association standard IS-95, for frequencies below 1 GHz, and in the Wideband Spread- Spectrum Digital Cellular System Dual-Mode Mobile Station-Base Station Compatibility Standard, for frequencies in the 1.8-1.9 GHz frequency bands, both of which are incorporated herein by reference. Furthermore, CDMA general principles have also been described, for example, in U. S. Patent 5,109,390, to ~~Gilhausen~~Gilhousen, et al, filed November 7, 1989 and CDMA Network Engineering Handbook by Qualcomm, Inc., each of which is also incorporated herein by reference.

Please replace the paragraph at page 29, lines 8-10 with the following:

(8.1) providing a multiple hypothesis computational architecture (as illustrated best in Figs. 8

and/or Fig. 13) wherein the hypotheses may be:

Please replace the paragraph beginning at page 34, line 16 and ending at page 35, line 2 with the following:

In other embodiments of the present invention, a fast, albeit less accurate location estimate may be initially performed for very time critical location applications where approximate location information may be required. For example, less than 1 second response for a mobile station location embodiment of the present invention may be desired for 911 emergency response location requests. Subsequently, once a relatively ~~course~~ coarse location estimate has been provided, a more accurate most likely location estimate can be performed by repeating the location estimation processing a second time with, e.g., additional with measurements of wireless signals transmitted between a mobile station to be located and a network of base stations with which the mobile station is communicating, thus providing a second, more accurate location estimate of the mobile station.

Please replace the paragraph beginning at page 43, line 19 and ending at page 44, line 14 with the following:

The MBS 148 acts as a low cost, partially-functional, moving base station, and is, in one embodiment, situated in a vehicle where an operator may engage in MS 140 searching and tracking activities. In providing these activities using CDMA, the MBS 148 provides a forward link pilot channel for a target MS 140, and subsequently receives unique BS pilot strength

measurements from the MS 140. The MBS 148 also includes a mobile station for data communication with the LC 142, via a BS 122. In particular, such data communication includes telemetering the geographic position of the MBS 148 as well as various RF measurements related to signals received from the target MS 140. In some embodiments, the MBS 148 may also utilize multiple-beam fixed antenna array elements and/or a moveable narrow beam antenna , such as a microwave dish 182. The antennas for such embodiments may have a known orientation in order to further deduce a radio location of the target MS 140 with respect to an estimated current location of the MBS 148. As will be described in more detail herein below, the MBS 148 may further contain a global positioning system (GPS), distance sensors, dead-reckoning electronics, as well as an on-board computing system and display devices for locating both the MBS 148 ~~of~~ itself as well as tracking and locating the target MS 140. The computing and display provides a means for communicating the position of the target MS 140 on a map display to an operator of the MBS 148.

Please replace the paragraph beginning at page 47, line 5 and ending on page 47, line 16 with the following:

A location application programming interface ~~136 (Fig. 4)~~, or L-API 14 (see Fig. 14, and including L-API-Loc_APP 135, L-API-MSC 136, and L-API-SCP 137 shown in Fig. 4), is required between the location center 142 (LC) and the mobile switch center (MSC) network element type, in order to send and receive various control, signals and data messages. The L-API 14 should be implemented using a preferably high-capacity physical layer communications interface, such as IEEE standard 802.3 (10 baseT Ethernet), although other physical layer

interfaces could be used, such as fiber optic ATM, frame relay, etc. Two forms of API implementation are possible. In the first case the signals control and data messages are realized using the MSC 112 vendor's native operations messages inherent in the product offering, without any special modifications. In the second case the L-API includes a full suite of commands and messaging content specifically optimized for wireless location purposes, which may require some, although minor development on the part of the MSC vendor.

Please replace the paragraph beginning on page 63, line 22 and ending on page 64, line 7, with the following:

(c) For each base station 122, BS_i, in the group mentioned in (b) above, create an empty list, BS_i-list, and put on this list at least the P_0 area types for the "significant" P_0 subareas crossed by the transmission path between C(A) and BS_i. Note that "significant" P_0 subareas may be defined as, for example, the P_0 subareas through which at least a minimal length of the transmission path traverses. Alternatively, such "significant" P_0 subareas may be defined as those P_0 subareas that additionally are know<u>n</u> or expected to generate substantial multipath.

Please replace the paragraph at page 66, lines 3-18 with the following:

Accordingly, assuming the partition P_0 <u>as described immediately above</u> is used, a description can be given as to how probabilities may be assigned as the confidence values of

location hypotheses generated by the first order models 1224. For each partition area A, a first order model 1224 is supplied with wireless measurements of archived location data in the Location Signature Data Base associated with corresponding verified mobile station locations. Thus, a probability can be determined as to how likely the first order model is to generate a location hypothesis having a location estimate containing the corresponding verified mobile station location. Accordingly, a table of partition area probabilities can be determined for each first order model 1224. Thus, when a location hypothesis is generated and identified as belonging to one of the partition areas, the corresponding probability for that partition area may be assigned as the confidence value for the location hypothesis. The advantages to using actual probabilities here is that, as will be discussed below, the most likelihood estimator 1344 can compute a straightforward probability for each distinct intersection of the multiple location hypotheses generated by the multiple first order models, such that each such probability indicates a likelihood that the target mobile station is in the corresponding intersection.

The following paragraph beginning at page 83, line 19 and ending at page 85, line 11 has only formatting changes.

(30.4) the hypothesis evaluator 1228 may determine if (or how well) such location hypotheses are consistent with well known physical constraints such as the laws of physics. For example, if the difference between a previous (most likely) location estimate of a target MS and a location estimate by a current location hypothesis requires the MS to:

(a1) move at an unreasonably high rate of speed (e.g., 200 mph), or

(b1) move at an unreasonably high rate of speed for an area (e.g., 80 mph in a corn patch), or

(c1) make unreasonably sharp velocity changes (e.g., from 60 mph in one direction to 60 mph in the opposite direction in 4 sec), then the confidence in the current Location Hypothesis is likely to be reduced.

Alternatively, if for example, the difference between a previous location estimate of a target MS and a current location hypothesis indicates that the MS is:

(a2) moving at an appropriate velocity for the area being traversed, or

(b2) moving along an established path (e.g., a freeway),

then the confidence in the current location hypothesis may be increased.

Please replace the paragraphs beginning at page 101, line 18 and ending at page 102, line 21 with the following:

A fourth functional group of location engine 139 modules is the control and output gating modules which includes the location center control subsystem 1350, and the output gateway 1356. The location control subsystem 1350 provides the highest level of control and monitoring of the data processing performed by the location center 142. In particular, this subsystem performs the following functions:

(a) controls and monitors location estimating processing for each target MS 140. Note that this includes high level exception or error handling functions;

(b) receives and routes external information as necessary. For instance, this subsystem may receive (via, e.g., the public telephone switching network 124 and Internet ~~1362~~ 468) such environmental information as increased signal noise in a particular service area due to increase traffic, a change in weather conditions, a base station 122 (or other

infrastructure provisioning), change in operation status (e.g., operational to inactive);

(c) receives and directs location processing requests from other location centers 142 (via, e.g., the Internet 468);

(d) performs accounting and billing procedures;

(e) interacts with location center operators by, for example, receiving operator commands and providing output indicative of processing resources being utilized and malfunctions;

(f) provides access to output requirements for various applications requesting location estimates. For example, an Internet location request from a trucking company in Los Angeles to a location center 142 in Denver may only want to know if a particular truck or driver is within the Denver area. Alternatively, a local medical rescue unit is likely to request as precise a location estimate as possible.

Please replace the paragraph at page 103, lines 1-5 with the following:

Referring now to the output gateway 1356, this module routes target MS 140 location estimates to the appropriate location application(s). For instance, upon receiving a location estimate from the most likelihood estimator 1344, the output gateway 1356 may determine that the location estimate is for an automobile being tracked by the police and therefore must be ~~provided must be~~ provided according to ~~the~~ a particular protocol.

Please replace the paragraph at page 104, lines 2-10 with the following:

The stochastic first order models may use statistical prediction techniques such as principle decomposition~~, partial least squares,~~ partial least squares, or other regression techniques

for predicting, for example, expected minimum and maximum distances of the target MS from one or more base stations 122, e.g., Bollenger Bands. Additionally, some embodiments may use Markov processes and Random Walks (predicted incremental MS movement) for determining an expected area within which the target MS 140 is likely to be. That is, such a process measures the incremental time differences of each pilot as the MS moves for predicting a size of a location area estimate using past MS estimates such as the verified location signatures in the location signature data base 1320.

Please replace the paragraph beginning at page 104, line 19 and ending at page 105, line 15 with the following:

Regarding FOMs 1224 using pattern recognition or associativity techniques, there are many such techniques available. For example, there are statistically based systems such as "CART" (an acronym for Classification and Regression Trees) by ANGOSS Software International Limited of Toronto, Canada that may be used for automatically detecting or recognizing patterns in data that were unprovided (and likely previously unknown). Accordingly, by imposing a relatively fine mesh or grid of cells ~~of~~ on the radio coverage area, wherein each cell is entirely within a particular area type categorization such as the transmission area types (discussed in the section, "Coverage Area: Area Types And Their Determination" above), the verified location signature clusters within the cells of each area type may be analyzed for signal characteristic patterns. If such patterns are found, then they can be used to identify at least a likely area type in which a target MS is likely to be located. That is, one or more location hypotheses may be generated having target MS 140 location estimates that cover an area having

the likely area type wherein the target MS 140 is located. Further note that such statistically based pattern recognition systems as “CART” include software code generators for generating expert system software embodiments for recognizing the patterns detected within a training set (e.g., the verified location signature clusters).